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Evaluation of Surface Dose to the Thyroid Region of Pediatric Patients Undergoing Antero-Posterior Chest X-ray Examination

Herath HMLSB*, Wickramarathne RLA*, Pallewatte AS, Herath LHMIM***

* Department of Radiography & Radiotherapy, General Sir John Kotelawala Defence University
** Department of Neurosurgery, National Hospital-Colombo

Abstract- Ionizing radiation used in medical imaging has probability to establish carcinogenesis and it is important to measure the radiation doses to critical organs of known sensitivity to the stochastic effects. Due to the small size of pediatrics' body, the chest X-ray examinations are associated with high radiation exposure of non-relevant adjacent organs such as the thyroid gland. Since the thyroid cancer, particularly in pediatrics has been well established and the increasing risk of thyroid cancer from low levels of medical diagnostic X-rays has been highlighted, we aimed to measure the surface dose to the thyroid gland of pediatrics undergoing antero-posterior (AP) chest examination. After assessing each patient against specific inclusion-exclusion criteria, 100 pediatric patients who underwent AP chest X-ray examination were considered eligible for this study. The surface dose to thyroid gland was measured for each patient using high sensitive electronic pocket dosimeter (EPD) (PMD 117) and mean surface dose of all patients was calculated. The overall mean surface dose at the thyroid gland level during chest examination was 0.0127±0.0081 mGy (ranged from 0.00359 to 0.057 mGy). Since the national diagnostic reference level (DRL) is unknown, there is no possibility to compare the current results with DRL. When we compare the current results with a similar study done in Iran using thermo luminescent dosimeters (TLD), it was realized that the mean dose value of our study is lower than that published value of 0.065±0.053 mGy. Due to lack of national DRLs for X-ray imaging and published national report on the thyroid surface dose in X-ray imaging, it is impossible to say the current dose values are acceptable or not. However, we hope this study will play a small role in setting DRL for paediatric chest X-ray imaging in SriLanka with the help of further studies.

Index Terms- Antero-posterior, Chest X-ray, Pediatric patients, Surface dose, Thyroid region

I. INTRODUCTION

IN developed countries several dose surveys in diagnostic radiology have been done while in developing countries such information is still lack. Since the medical exposure is the most important source of public exposure and ionizing radiations used in medical imaging has probability to establish carcinogenesis, measuring the dose received by the patients is widely considered as an important quality control tool in medical radiology [1], [2], [3].

According to Karami *et al*. [1] the pediatrics are sensitive to radiation carcinogenesis about ten times compared to the adults.

Since the chest radiography is the most common X-ray examination of all X-ray examinations [4], it is consider that pediatric chest X-rays highly contribute to the radiation exposure to the thyroid gland [1], [5].

Ron *et al*. [6] say the thyroid gland in children has one of the highest risk coefficients of any organ.Since the pediatrics' body are small in size and pediatrics' chest radiographs are routinely performed in anterior-posterior (AP) view instead of posterior-anterior (PA) view, radiation exposure of non-relevant adjacent organs such as the thyroid gland is high [5]. According to the Department of Pathology, University of Pittsburgh, after the Chernobyl nuclear accident in April 1986, there was an increased incidence of thyroid cancer in the exposed children remains well-documented and long-term [6].

In the countries which have advanced medical systems, guidelines for medical exposures have been set since many years ago and are clinically applied now [7]. In Sri Lanka, as many other developing countries, there is no guideline for medical exposures. To the best of our knowledge, there is no evidence for the study that evaluated the radiation exposure to the thyroid gland in pediatric chest X-rays in Sri Lanka.

The main purpose of this study was to measure the surface dose to the thyroid region for pediatric chest radiography and compare the mean surface dose value with the previous studies in order to help in optimizing the chest radiography. We hope that similar nationwide studies are performed and the radiation exposure of the patients set under the levels proposed by the international authorities.

II. MATERIALS AND METHOD

A. Sample

After assessing each patient against specific inclusion-exclusion criteria, 100 pediatric patients who were undergoing anterior-posterior (AP) projection of the chest X-ray were selected. Patients were considered eligible for inclusion if their ages were 12 years or younger, could cooperate to the requirements of the study and their parents gave informed consent. Other patients that did not meet our inclusion criteria were omitted from the study. Hundred pediatric patients with chest radiography were considered eligible and the standard supine AP projections were obtained.

B. Ethical Considerations

The ethical review committee of General Sir John Kotelawala Defense University approved the study protocol (grant No. RP/S/2016/11). The written consent was obtained from the parents before the study.

C. Data Acquisition

According to the international guidelines [8], the exposure field size should cranially be limited to the lower cervical area and caudally to the lower abdominal area at the level of T12/L1 vertebras with maximum variation tolerance of 2 cm in each side.

The surface dose to thyroid region was measured for each patient using high sensitive electronic pocket dosimeter (EPD) (PMD 117) with a digital display manufactured by Hitachi Aloka Medical, Ltd., Tokyo, Japan. This instrument is a best suited medical device which can measure above 20 keV of X and Gamma rays. It is a direct-reading dosimeter which displays an accumulated dose. The range of dose measurement used in the EPD varied from 1-9999 µSv. It has a silicon semiconductor detector and calibrated by Am-241 using a slab phantom. In order to prevent of physical damages, this EPD was kept inside a prepared radiolucent cloth bag. To measure the dose, EPD was placed on the neck where thyroid gland is located (at a point mid- way between the sternal notch and the cricoid cartilage in the midline) [9].

D. Statistical Analysis

SPSS version 15 was used as statistical tools. P-value less than 0.001 was considered statistically significant. Comparison of average surface dose of the thyroid gland during chest radiography with the value reported by Karami *et al*. [9] in Iran using thermo luminescent dosimeters (TLD) was made using z-test.

III. RESULTS

Patients age was under 12 years, the average weight and height of patients were 21.3±6.8 kg (9.5 - 42) and 121.2±10.7cm (97 - 157), respectively. The tube voltage was between 44 and 70 kVp at 3 to 6.25 mAs. The average thyroid surface dose was 0.0127±0.0081 mGy compared with the average thyroid surface dose given in the similar literature of 0.065±0.053 mGy. The result of the present study produced a statistically significant decrease in the average thyroid dose when compared with above value (P-value < 0.001).

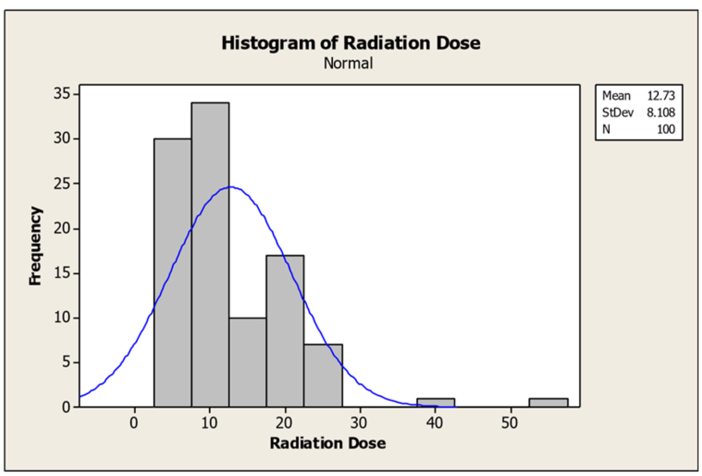

Fig. 1. Radiation dose distribution among patients.

IV. DISCUSSION

Gustafsson *et al.* [10] investigated the risk of future radiation inducing malignancies due to infant and children chest radiography and highlighted that radiation induced leukemia and thyroid carcinoma constituted the greatest risk of future malignancies.

Due to the cumulative dose and stochastic risks there should be a real concern about radiation dose received by the organs when an individual undergoes multiple and more frequent X-ray examinations such as the chest X-ray that is the most frequent X-ray examination throughout the world [11]. Eisenberg *et al.* [12] and Brenner *et al.* [13] revealed that multiple procedures in an individual patient can result in a cumulative dose of more than 50 mSv per year that approachesor exceeds the levels which known as increased cancer risk.

With regards to CT scans and other diagnostic radiographies, the American Thyroid Association (ATA) recommends the use of thyroid shields when possible to protect the thyroid. These procedures may involve clinically relevant radiation doses to the thyroid, especially when more than one examination is performed, and the goal is to reduce thyroid exposure as much as feasible.

In our study, average surface dose received by thyroid region was 0.0127±0.0081 mGy and this is lower than the value of 0.065±0.053 mGy given in only one published similar study done in Iran using TLDs.

Due to lack of national diagnostic reference levels (DRL) for X-ray imaging and published national or international report on the thyroid surface dose in X-ray imaging, it is impossible to say the current dose values are acceptable or not.

However, we hope this study will play a small role in setting DRLs for paediatric chest X-ray imaging in SriLanka with the help of further studies.

V. CONCLUSION

The measured surface doses in our study don't exceed the doses reported by Karami et al. [9]. However, as in Sri Lanka there is no national DRLs for chest X-ray examination, it is not clear whether the current dose values are acceptable or not.

The authors wish to suggest that establishing of national diagnostic reference levels is important so that the researchers can compare their work and change their attitude and philosophy. It can be concluded that the further studies should be done to establish those DRLs.

Moreover, surface dose received by thyroid gland during chest X-ray examination can be further reduced by protecting the thyroid using lead shields.

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AUTHORS

First Author – Herath HMLSB,BSc (Hons) Radiography, General Sir John Kotelawala Defence University, lakmalup@yahoo.com
Second Author – Wickramarathne RLA, BSc (Hons) Radiography, General Sir John Kotelawala Defence University, aroshana2u@gmail.com
Third Author – Pallewatte AS, Consultant Neuroradiologist, National Hospital-Colombo, asp31263@hotmail.com
Fourth Author–Herath LHMIM, BSc (Hons) Radiography, Lecturer, General Sir John Kotelawala Defence University, indeewariherath23@gmail.com

Correspondence Author – Herath LHMIM,indeewariherath23@gmail.com, 0774260129